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In the metal working and stamping industry the focus is on a clean cut or form. A clean cut or formation that does not cause the metal to stretch or lose its strength. After that, cost and production rate concerns make the next most important requirement the desire to provide a lubricant that will extend the life of the tooling needed to form the product. One of the most effective additives to a metal working fluid to enable the presses, mills or die to provide those two characteristics is chlorinated paraffin.

A chlorinated paraffin is an additive to a lubricant that has as its base a paraffin, or wax. The wax in the lubricant helps the lubricant itself to stick to the parts as they are being formed. Whether it is a broaching operation, stamping operation or any other type of metal forming application, the paraffin forces the lubricant to cling to the metal and form a shield of lubricity at the cutting edge. This lubricity shield does not allow the metal to weaken during formation and, therefore, allows the shop to turn out a quality product.

Chlorinated paraffin is used in nearly all the metal working industries, as well as some non-metalworking industries. This base can be found in lubricants used for drawing, turning, milling, tapping, honing, and fine blanking. A waxy base can also be found in some grinding coolants to keep the blades fresh. It has also been found in motor oil as a way to improve horsepower because of its ability to reduce friction within the engine.

In the metal working industries mentioned above, once on, this paraffin needs to come off. It needs to come off not only because cosmetically, this lubricant’s smutty, oily black and gold residue make the parts look bad, but it needs to be removed because nothing will adhere to the part with the paraffin still on it. This shield that is formed is excellent for tool life and metal protection, but unless the part is washed clean of the product, the next process will not be successful. Specifically, until the part is clean, it cannot be painted or plated in any way.

Even so, if the next step in the manufacturing process is not a plating or painting operation, the paraffin can still create problems if it is not cleaned off sufficiently. The oily residue left on the part may react negatively with oils or other metal working fluids that are subsequent to the forming process.

Getting the parts clean is the problem. This is the step in the manufacturing process where the chlorinated paraffin’s negative aspects begin to show themselves. Since they are sticky to the point of resembling a honey like substance the parts need to be cleaned in a very specific manner. The variables of spray impingement, submersion of the parts, heat of the water, time in process and alkalinity of the cleaning compound will all play a part in the result desired.

Spray and immersion are two actions that must be used in conjunction with each other in order to obtain optimum results. Spray allows the mechanical force of the nozzles to direct cleaning solution at the substrate and mechanically break free the waxy coating from the surface. Logically, the higher the psi of the spray, the more effective the cleaning of the surface. There is a limit, however, to when the psi force is not worth the additional costs or concerns associated with attaining this force. Additional costs include higher capacity pump, sound guarding for the higher psi pump, and thicker plate hood or drum walls for the stronger spray. Also, the high psi spray, if not managed, can damage the stampings. If this occurs, then the entire washing process has just made the manufacturing process worthless. Thus, discovering the psi limit is one of the keys to the washing solution.

Submersion allows the chemical action to take place by creating a situation where the surfactant in the cleaner can get under and lift off the waxy substance using its molecular characteristics. This lift off will occur when the part is submersed in a fluid containing a surfactant that will reduce the surface tension of the paraffin to the metal. These surfactants must be able to get between the substrate surface and the clinging paraffin and force the paraffin to work its way free.

The surfactant must then force the paraffin to stay emulsified in the solution until it reaches a saturation point in the tank bath. At that point it will cause it to drop to the bottom of the tank. Of course, if it were possible to create a cleaning compound that would make the chlorinated paraffin float rather that sink, then parts washers could use the proven technology of oil water separation found in devices such as the Suparator to treat the fluid in process. The difficulty in doing this is that while most oils are lighter than water and thus will float when they are washed off, devices like the Suparator cannot skim Chlorinated Paraffin off the top of the water because it is heavier than water by about 15% - 20%. The challenge here is to both treat and dispose of sludge that forms and drops to the bottom of the tank or come up with a product to separate the paraffin molecules enough so they can be skimmed off of the top.

The other cleaning variable that cannot be underestimated is the temperature of the water. The paraffin, as mentioned before, is a wax. The trick is to get the water hot enough so that it melts the wax to give assistance to the mechanical and chemical action taking place to separate the soil from the part. The problem arises when a wash process requires a multi fluid stage system. This is necessary to avoid early saturation in the bath life and to allow different cleaning and rust inhibiting agents to each perform their task. If the water gets too hot it will encourage flash drying of the part.

This can be good if one stage is all that is needed to clean and finish the part. If multiple stages are required though, then flash drying will make it impossible to achieve the result desired. For example, the part travels through the wash or pre-wash stage. The water is hot so it melts off most of the paraffin based lubricant. As it continues to travel to the next stage of the washer it will travel through a dwell area that will allow the part to drain before it enters the next fluid stage, thus limiting tank cross contamination. During this dwell period the part can flash dry due to the heat absorbed by the part in the first fluid stage. If it does and the part is still holding even a small residual amount of the paraffin on the part, then the only way it will come off is to rub it off with a cloth by hand.

Testing must be done in order to determine the lowest temperature that still is hot enough to aid in soil removal, yet will not flash dry before the entire washing process is complete.

Tests were recently conducted at the Midbrook Technology Center in order to determine the best combination of the below variables to achieve a clean part. The following is a list of these variables. I have also listed the different conditions for each of these variables that we hypothesized would achieve the best results.

Spray psi – 20psi, 60psi, 100psi

Time sprayed - 1 minute duration , 20 second duration

Time submersed – 6 minutes, 2 minutes

Cleaner concentration base – 8%, 10%, 12%

pH of cleaner – 12 potassium hydroxide, 8 citric cleaner

Water Temperature – 130F, 150F, and 170F

Based on the variables above, a series of tests were performed. Each test altered one variable, while keeping all others the same. At the completion of the testing process nearly 50 sets of parts were sent through a small rotary drum washer with varying spray.

After the tests were completed, the method used to determine the best set of variables was the white glove test and the black light test. Although each of these tests are not what we would normally use in a state-of-the-art part testing lab, they are the only ones that would give an accurate account of the results due to the nature of the soil. Tests like the particle counter were useless because we were testing for a film, not particles. Also, gravimetric testing would not be worthwhile. If the spray in the washer does not clean the part off, spraying to get the residual to run down into a basin and then processing it through a filter would not give an accurate weight of the soil still there.

The findings include the following observations. Time under spray was not as effective as time in submersion. The longer the part was submersed, the more effective the cleaning process was.

The hotter the fluid, the better the cleaning to a point. When the water temperature was 130F, the results were not acceptable when compared with the results achieved at 150F. At 170F, however, we did not see any noticeable improvement.

The citric cleaner with a pH of 8 was not nearly as effective at any temperature as the potassium hydroxide based cleaner with a pH of 12 was at all temperatures.

Finally, the optimum concentration ratio of potassium hydroxide cleaner appeared to lose its effectiveness above 10%. Any higher concentration and the stainless steel parts tended to darken, rather than appear brighter. The aluminum parts became more heavily laden with white rust.

Based on these results Midbrook would recommend washing the parts in a large, slow moving, submersible rotary drum with a light spray. The water heat should be at least 150F with a 10% concentration of a moderately high pH cleaner with a surfactant package that contains potassium hydroxide.

Once the washing is complete and the part is achieving the desired level of cleanliness, the focus must now shift to how to keep the process moving. Volume is what makes money in the stamping and forming industry. The faster the parts can come off the press the better. The more the line is up and running, the better. The number of times the washing process needs to be drained, cleaned and refilled will play a significant role in how profitable or costly the process becomes.

As mentioned previously, the present state of the cleaning compound industry does not offer a product that will enable the chlorinated paraffin to float and be removed via oil water separation systems. The alternative is for the customer to choose one, or a combination, of the following in-process methods of sludge removal systems.

The chlorinated soil will drop to the bottom of the tank after a certain level of tank saturation has taken place. The problem with this fallout is the chlorinated, waxy film then begins to wreak havoc with components residing below the water's top surface.

Water heating devices, whether they be electrical heating elements, gas heat immersion tubes or steam plate coils are stationed just above the bottom of the tank. When sludge coats these, the sludge insulates the heat being created and does not allow it to be released into the water. This insulating effect causes enough stress to encourage these heat devices to fail. In addition to these failures, pump inlets, which are normally located at the bottom of the tank, soon become blocked with the fallout. This starves the pump of fluid and burns up the pump motor.

To avoid this fallout to the bottom, one strategy is to create a false bottom that stretches the length and width of the tank. A bottom that captures the fallout before it drops and becomes a problem to the components. To make best use of this false bottom, it should not be attached on a level horizontal plane. Rather, it is recommended to slant that false bottom at an angle that will not only allow the fallout to be captured before it reaches the real bottom, but will encourage the fallen sludge to slide to one end of the tank. Using the simple force of gravity can do this, or the sludge can be pushed along to one specific side by running a series of spray nozzles along the false bottom's surface to help push the sludge along.

Once the sludge begins to be collected in the one area of the tank, it must be removed. One way to accomplish this is to use an air diaphragm style trash pump to pump the sludge from the tank to a holding drum for disposal. The most obvious drawback to this method is that there will be a great deal of water that is pumped out with the sludge. Careful monitoring will need to be done to make sure the proper water levels are maintained. Frequent, regular chemical titration will need to be done to assure proper compound ratios continue to be present in the tank despite the constant removal of chemistry laden sludge. This regular titration will require frequent adding of compound, which undoubtedly will prove to be quite expensive. In fact, it will need to be determined which is less costly: down time to change the tank or frequent chemical additions.

An alternative to the pump out is to employ a sludge drag out system. This drag out method will appear similar in style and function to a magnetic chip conveyor, or H.R. Black style filter. A belt travels through the sludge pit of the tank. Water is squeezed out before it gets out of the tank area. Much like your grandma's old ringer washing machine. Then at an elevated area outside of the tank the remaining sludge is scraped off into a container, while the belt continues to travel toward the sludge pit again. Once again, much chemistry will be dragged out in the sludge, but theoretically, not as much as what would have been pumped out.

Other modifications can be made to extend bath life. One adjustment is to attach a 90-degree elbow and then a pipe extension between the pump and the pump's inlet. This will force the pump to pull from the middle of the bath instead of its normal bottom pull position.

Another modification would include adding a "T" into the manifold line and plumbing it down to the bottom of the tank. From there, use an elbow fitting to add a longer pipe manifold with nozzles that would be directed out toward the bottom of the tank and spray while the unit runs. This additional manifold will continue to agitate the sludge so it stays suspended longer in the solution rather than settling onto the bottom components in the tank.

These methods of extending washer bath life will have to be used until one of two things happen. First, a cleaning compound is developed to lift the Chlorinated Paraffin off of the part and then make it float on the water's surface. The other alternative is to push the development of esters to be used as the lubricity agent in place of Chlorinated Paraffin. Esters are lighter that water and will float to the surface so they can be removed with an effective oil-water separation system.

Esters are also a sticky residue that acts as a lubricity shield, however, they are not used in a deep draw, extreme pressure application. Those presently on the market are just not as effective in protecting tooling or in protecting the metal during the formation of the metal as the chlorinated paraffin is. As a result, tooling would need to be changed often and the metal that has been formed will not have the strength of that metal formed using chlorinated paraffin. Until they are, the in-process treatment of wash water in the metal working industry will need to find creative solutions to extend bath life in order to be as profitable as the industry demands.